A STUDY OF FLOOR COATINGS

CLEAR AND PIGMENTED

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A STUDY of floor coatings, clear and pigmented, involves the careful consideration of a multiplicity of exposure problems. It has been common practice to include porch and deck paints and varnishes as well as interior floor finishes in the overall term "floor coatings". Consider for a moment the wide range of exposure conditions, the great number of surfaces (including wood and concrete) and the extreme conditions of abrasive wear to which these films are subjected and you will realize the stringent demands placed upon the formulator. The enormity of the problem that has confronted the paint chemists of the past and present has constituted a challenge that has been more than adequately met and the industry can feel proud for the most part in the progress thus far achieved. Let us hasten to add, however, that the many difficulties have been far from solved. The ultimate in floor coatings is still hanging in some distant research horizon.

A scientific evaluation of the raw materials and finished products of the past in comparison or combination with the complex synthetic materials of the present and near future is often necessary in a study of this kind. As a result, research programs were set up in the last few years that have given pause to the headlong rush into wholehearted acceptance of new promises and theories. Sober estimates of the results of these investigations give rise to surprising conclusions and thrust forward for examination combinations of raw materials that have proven to be extremely interesting.

The number of chores to be performed by floor varnishes necessitates very careful formulation. Floor coatings must, of course, have good abrasion resistance and adhesion. Since they are subjected to all types of abusive traffic, their toughness and tenacity to the surface on which they are applied should be of prime consideration.

Soap and alkali resistance must also be investigated since the coatings are usually given frequent washings. In the case of concrete floors, they must be able to withstand some residual alkali conditions. The latter, however, is of somewhat minor consideration since concrete floors should be chemically treated to neutralize alkali before application of paint and varnish.

For porch and deck finishes, the varnishes applied must also show good resistance to exterior exposure. This type of exposure is one of the most difficult since it is subject to considerable sunlight as well as the destructive effect of salt spray and rain.

The varnishes that are developed for application to floors may see service in one of a number of forms. First, the varnishes may be applied as clear finishes and when this is the case, good color is a prerequisite almost as important as the others. The varnishes also may serve as the sole vehicle in enamels or paints or they may also be present as a portion of the vehicle to which oils or other nonvolatile constituents are added. In most cases, the floor varnish serves as the sole vehicle. As such, it bears considerable brunt of the stringent exposure conditions to which floor varnishes are subjected.

In short, then, floor coatings, regardless of type, have a tough protective job to do and their development and preparation should not be taken lightly. Complete review of past experience and exposure data should be considered as well as the

chemical and physical tests in the laboratory before final approval is given to a floor paint or varnish formula.

Just prior to World War II, the New England Paint and Varnish Production Club conducted a study of floor varnishes that has become classic in its detached, thorough evaluation of Natural Resins in combinations with Synthetic Resins.[1] No investigation of floor coatings in the paint and varnish field would be complete without a survey of the work done by this group. The New England Club set out to determine if the natural resins could improve the "toughness, wear resistance and general durability of floor varnishes." The inspiration to work on the problem along those lines was drawn from oft repeated statements that the "old time" floor varnishes were superior in durability to the modern day finishes.

The resins chosen for evaluation are representative of the types that are widely used today as well as at the time of the study. The synthetic resins to be evaluated were:

Modified Phenolic Resin
100% Heat Reactive Phenolic
100% Soluble Type Phenolic
Ester Gum

The natural resins were:

Hard Dark Amber Congo No. 11
Pale Kauri No. 1
Pontianak Bold Scraped
Pale East India Bold
Black East India Bold
Batu Scraped

Four proprietary treated natural resins were also included.

GENERAL PROCEDURE

The procedure followed in the preparation of the over eighty varnishes investigated involved cooking each natural resin with each of the synthetics. A study of each natural resin constituted a series in which two resin blends with each synthetic were evaluated:

65% natural resin – 35% synthetic resin
35% natural resin – 65% synthetic resin

Cooks were also made with 100% Natural Resin and 100% Synthetic Resin.

The varnishes were formulated at a 25 gallon length, using 20 gallons Chinawood Oil and 5 gallons Bodied Linseed Oil. All varnishes were cooked to a viscosity between D-G and were thinned to approximately 50% solids. The investigation showed that it is preferable to follow the usual method of preparing natural resins for cooking with oils by "running." Natural resins can easily be made soluble in all oils and thinners by using this procedure. It involves heating the resin slowly to 610°-635°F and holding until the floating or insoluble lumps have disappeared. This can be done just prior to the actual varnish cook or stocks of resin may be prepared and held for future use.

SUMMARY OF RESULTS

The 100% Natural Resin Varnishes were especially marked by their tenacity and excellent adhesion. They showed signs, however, of early failure in abrasion resistance and were susceptible to the chemical attack of acid and alkali.

On the other hand, the 100% phenolic and modified phenolic varnishes showed much poorer

adhesion than the natural resin cooks while exhibiting good resistance to abrasion and the action of acid and alkali.

The combination of 65% natural resin with 35% phenolic resin showed very desirable results in almost all cases. Kauri, Congo, Batu and the East India resins gave exceptionally tough, durable and generally chemically resistant vehicles when used with low percentages of phenolic resins, excepting the heat reactive phenolic.

Interesting results were also obtained with the esterified Congo. This resin when used by itself had excellent toughness and resistance to abrasion but showed only fair alkali resistance while Batu, Black East India and Pale East India had fairly good resistance.

The reader is recommended to read the report of the New England Club in its entirety to digest the many points of interest that cannot be covered in this review. The conclusions drawn from this report are as applicable today as when they were originally presented, especially in light of the reintroduction of Chinawood Oil into the American market recently.

FURTHER STUDIES

The work of the New England Production Club prompted the American Gum Importers Laboratories, Inc. to extend their research indicated by the conclusions drawn in the Club's study. A program was thereupon set up to further determine the efficiency of *Natural Resins* in clear floor varnishes and also for vehicles in pigmented coatings.[2] It was decided to further investigate varnishes prepared with "unrun" or raw natural resins since there were indications that a carefully prepared varnish using the unprocessed resin might show superiority. A study was also to be made of the effect of increasing the proportions of natural resins over the synthetic resins when used in combinations.

The resins involved in this research were:

1. Thermally processed (Run) Pale East India
2. Thermally processed (Run) Batu
3. Thermally processed (Run) Pontianak
4. Pale East India (Raw)
5. Batu Scraped (Raw)
6. 100% Phenolic (soluble type)
7. Ester Gum

All of the resins were cooked at 25-gallon length (20 gallon Chinawood Oil and 5 gallon "Q" Bodied Linseed). They were thinned with mineral spirits to a non-volatile content of approximately 50%.

Cooking procedure varied essentially only when raw or processed natural resins were used. The processed or run resins were prepared by heating the raw resin to 630°F. and holding until foaming had subsided. This resin was then cooked in normal procedure with the oils.

With the unprocessed resin it was necessary to cook all the resin with one-quarter the amount of Chinawood Oil to 600°F. and hold until foaming subsided and a bead of the cool mixture indicated complete clarity and compatibility (5-10 minutes). The balance of the wood oil was added and the cook then continued.

In all, 42 varnishes were prepared in this series. Cross blends of various resins were used so as to get a full estimate of the efficiency of each resin. The varnishes were to be tested primarily for drying characteristics, hot and cold water resistance, chemical resistance, gas proofness, hard-

ness, adhesion, resistance to abrasion, toughness and package stability. To simplify this analysis, only the most significant varnishes will be evaluated and discussed.

EVALUATION OF RESULTS

As in the New England study, the addition of phenolic resins was in general detrimental to adhesion. It was also found that the presence of the phenolic resin did not contribute to stability with regard to drying. Varnishes were watched for loss in drying power after a five month storage period and it was shown that the increase in time required for drying was directly proportional to the amount of phenolic resin present. With this knowledge, however, it is quite possible to adjust the drier concentration to permit the use of phenolic resins with no serious drying loss. It might also be added here that in the formulation of paints with these phenolic resin formulae, it is well to include small amounts of litharge or certain proprietary additives to prevent loss of drying power on aging. The addition of at least 10% phenolic resin overcame any gas proofing difficulties and also gave greater chemical resistance.

Careful examination of the testing data revealed that the natural resins gave excellent adhesion and toughness. Batu, generally, gave slightly better results than the Pale East India while Pontianak did not measure up quite so well.

Varnishes prepared with the unprocessed natural resins seemed to give better results in most respects than the run resins. It should be mentioned that if the cooking done with the unprocessed resin is handled carefully and complete clarity is obtained before the addition of the bulk of the wood oil, that the package stability will be excellent. The varnish will generally be superior.

Although previous results indicated that the use of large amounts of ester gum did not give very good results, this study showed that the incorporation of 10-25% of ester gum with a natural resin such as Batu imparts slightly greater toughness to the film.

Two typical varnishes might serve to sum up the results found in this research. The first will give a tough, high gloss finish with excellent adhesion and only fair gasproofness. It provides a good general purpose floor varnish:

85 lbs. Batu Scraped (Unprocessed)
15 lbs. Ester Gum (low acid)
20 gallons Chinawood Oil
5 gallons "Q" Bodied Linseed Oil
Mineral Spirits to 50% non-volatile content.
Driers equivalent to 0.5% Lead, 0.02% Manganese and 0.01% Cobalt on weight of the oil.

Where greater chemical resistance and gasproofness is desired, the following varnish is recommended:

85 lbs. Batu (Unprocessed)
15 lbs. 100% Phenolic Resin
20 gallons Chinawood Oil
5 gallons "Q" Bodied Linseed Oil
Mineral Spirits and Driers same as above.

The procedure used in cooking both these varnishes is as follows: Heat the resins and one-quarter of the Chinawood Oil to 600°F. in about one hour. Hold until foaming has subsided and a cold bead is *very clear* (about 10 minutes). Allow to cool to 520°F. Add remainder of the Chinawood Oil. Heat to 560°F. Hold for body. Check with bodied linseed oil.

The latter varnish makes an outstanding general purpose floor coating especially in a pigmented system. The rapid dry, toughness and high tensile strength recommended it as an ideal vehicle for interior or exterior floor enamels.

Some subsequent experiments also bore out the inference made in the New England Club paper that Congo could be used successfully in this type of formulation. Congo resin can be especially noted for its ability to form films with exceptionally fine adhesion and toughness.

The formulation of varnishes of 35-40 gallon oil length (85% Chinawood Oil—15% Bodied Linseed) with a resin content of 85% Batu and 15% (100%) Phenolic Resin can follow the same general procedure as described above. However, with this combination of oils and with the longer oil length, a first grade spar varnish can be produced. This varnish will sacrifice initial hardness for exceptional outdoor durability and will do an excellent job in withstanding the most severe weather conditions. Marine paints and varnishes can be based on this type of formula with excellent results to be anticipated.

Naturally, it is suggested that the longer oil varnishes be used in those paints requiring exterior exposure. For interior floor enamels, the shorter oil vehicles would be more suited to the abrasive traffic to which they are usually subjected. It might be suggested, parenthetically, that varnishes even shorter than the 25-gallon length, receiving attention in the studies mentioned above, would be eminently suited for interior floor paints in light of the additional toughness and adhesion achieved. Lengths of 15 to 20 gallons will give quick drying, extremely tough coatings.

PIGMENTATION

The floor vehicles, as suggested, have proven to be superior bases for the preparation of floor paints and enamels. Due to their tendency to develop high acid values, these natural resins should not be formulated with highly reactive pigments. In fact, the use of a reactive pigment, such as zinc oxide, is made unnecessary by the hardness and excellent adhesion of the varnishes that have been described. It is easily possible to formulate pigmented coatings of good hiding, fine appearance and extremely good durability with those varnishes. Pigmentation, of course, should be based on the end use of the coating in regard to type of exposure as well as the amount of traffic that it will have to undergo.

A porch and deck paint that will exhibit fine durability and appearance is one produced from the long oil (35-40 gallon) length, Batu-Phenolic Varnish and a pigmentation containing non-chalking titanium dioxide and magnesium silicate. The formulae for both the varnish and the paint are as follows:

38 GALLON PORCH AND DECK VARNISH

Batu Scraped (Unrun)	85 lbs.
100% Phenolic Resin	15 lbs.
Chinawood Oil	32 gallons
"Q" Bodied Linseed	6 gallons

Heat resins and 8 gallons Chinawood Oil to 600°F. Hold for complete clarity. Cool to 520°F. Add balance Chinawood Oil. Heat to 560°F. Hold for body. Check with linseed. Cool to 400°F. Thin to 50% solids with mineral spirits. Add driers as 0.4% Lead, 0.04% Manganese, 0.02% Cobalt on the weight of oil.

The following paint is suggested as a tint base for lighter shades of porch and deck paints:

Rutile Titanium Dioxide (non-chalking)	100 lbs.
Medium Oil Magnesium Silicate	300 lbs.
Porch and Deck Varnish	630 lbs.

For the all purpose interior-exterior floor enamels, the introduction of the non-chalking rutile titanium calcium pigments into the formula is suggested. The 25 gallon length varnishes described earlier in this paper will stand the formulator in good stead. Approximately 3½ lbs. to 4 lbs. of titanium calcium pigment per gallon will give superior opacity for most tint bases and will produce very good color retention and appearance.

For interior quick drying floor enamels, the non-chalking titanium calcium is not required, but standard rutile titanium calcium pigment in the same quantities will serve very well. Here, oil lengths of about 18 gallons will, as a result, give vehicles of quick, hard dry and good abrasion resistance.

For the deeper colors, 100% iron oxides, umbers and siennas may be used with various inerts to give paints of any desired shades. It is suggested that precipitated calcium carbonate should *not* be used in those paints where good outdoor exposure is needed. The paints containing the precipitated carbonate have a greater tendency to cracking on exterior exposure than the natural whitings.

CONCLUSION

A review of this type can merely emphasize the highlights in the considerable amount of work done on the preparation and evaluation of floor coatings. In recent years there has been a very healthy development in the paint and varnish industry toward a scientific and exacting study. *Natural Resins* have shown themselves to hold a firm place in this development and can stand along with the newer synthetics in the production of better and more attractive finishes.

Floor coatings, especially, have been found to be very much enhanced by the introduction of *Natural Resins* such as Batu, Pale East India and Congo, into their formulae. The paint and varnish industry can look back within its own experiences to help prove the soundness of looking forward to better results with the use of *Natural Resins.*

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[1]New England Paint & Varnish Production Club—"A Study of Natural Resins with Synthetic Resins for Floor Varnishes"—Federation Technical Paper, October 1939.

[2]Skett & Holzberger—"Natural Resins in Floor Varnishes"—Paint, Oil and Chemical Review, October 10, 1940.

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